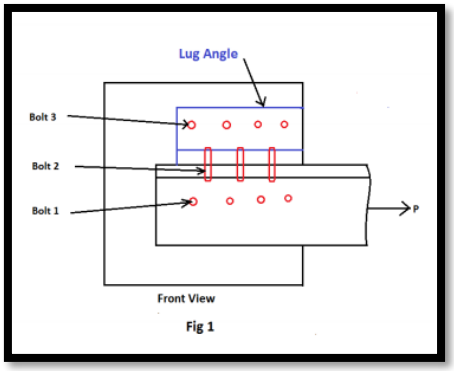
Answer all Questions

		MARKS	CO	RBT
1 (a)	What are lug angles? Explain with diagram. Lug angle is small piece of angle used to connect outstand legs of the members to the gusset plate. The purpose of lug angle is to reduce the length of connection to the gusset plate and to reduce shear lag effect.• If lug angle is used then the unconnected length of main angle behave like a connected leg and entire cross section• area of the angle become effective in resisting tension. So if lug angle is used, then efficiency of the tension member increases because it reduces shear lag effect. If lug angle is used the resultant reaction at bolt location 1 and 2 pass through CG of cross section. Since action and• reaction pass through CG of angle, stress and strain distribution are uniform hence no shear lag  Fig 1	[10]	CO1	L2
2 (a)	A single ISA 75 × 50 × 8 is connected (longer leg) with gusset plate using use 4 bolts of 20 mm diameter in one line at pitch of 50 mm and edge distance of 30 mm. What is the Design tensile strength due to block shear failure? (Assume gauge distance = 35 mm)	[20]	CO1	L2
3 (a)	Design a Lap joint between plates 100 x 8 mm so as to transmit a factored load of 100 kN using black bolts of 12mm diameter and grade 4.6.	[20]	CO2	L2

Solution:

$A_{vg} = 8 \times (3 \times 50 + 30) = 1440\ mm^2$

$A_{vn} = 8 \times (3 \times 50 + 30 - 3.5 \times 22) = 824\ mm^2$

$A_{tg} = 8 \times 40 = 320\ mm^2$ [assuming gauge g = 35 for 75 mm leg]

$A_{tn} = 8 \times (40 - 0.5 \times 22) = 232\ mm^2$

$$T_{db1} = \frac{0.9A_{vn}f_u}{\sqrt{3}\gamma_{m1}} + \frac{f_y A_{tg}}{\gamma_{m0}} = \frac{0.9\times410\times824}{\sqrt{3}\times1.25} + \frac{250\times320}{1.1} = 213.16 \times 10^3\ N = 213.16\ kN$$

$$T_{db2} = \frac{A_{vg}f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9\ f_u A_{tn}}{\gamma_{m1}} = \frac{1440\times250}{\sqrt{3}\times1.1} + \frac{0.9\times410\times232}{1.25} = 257.44 \times 10^3\ N = 257.44\ kN$$

So, $T_{db} = 213.16\ kN$.

1) Strength Calculations:

Nominal diameter of bolt d= 12 mm

For grade 4.6 bolt, f_u =40 kgf / mm^2=392.4 MPa, $_{mb}$ =1.25

Assuming threads in the shear plane, n_n=1, n_s=0

Shear Area of one bolt $A_{nb} = 0.8\ A_{sb} = 0.8 \times 113.1 = 90.5\ mm^2$

Design shear strength per bolt $V_{nsb} = f_u\ A_{nb} / \gamma_{mb}\ \sqrt{3}$ = 16.4 kN (Cl. 10.3.2)

Design bearing strength per bolt $V_{npb} = 2.5\ d\ t\ f_u$

$=2.5 \times 12 \times 8 \times 392.4 \times 10^{-3}$ =75.2 kN (Cl. 10.3.3)

Therefore, bolt value = 16.4 kN

No. of bolts required = 100 / 16.4 = 6.1 say 7 bolts

2) Detailing:

Minimum pitch = 2.5 d = 30 mm (Cl. 10.2.1)

Minimum edge distance = 1.4 D = 16.8 mm say 20 mm (Cl. 10.2.3)

Provide 8 bolts as shown in Fig. E1.